

TAXONOMIC STATUS OF *KORSCHTELLELLUS* BÖRNER IN NORTH AMERICA (LEPIDOPTERA: HEPIALIDAE)

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Abstract.—*Hepialus gracilis* Grote [1865], is transferred to the genus *Korscheltellus* Börner, 1925, a palearctic genus previously unrecognized from North America. *Hepialus furcatus* Grote, 1883, *H. mustelinus* Packard [1865], and *H. labradoriensis* Packard [1865], are synonymized under *Korscheltellus gracilis*. *K. gracilis* is redescribed, illustrated and its distribution and biology reviewed. The interception in Florida of a related species *K. fusconebulosus* (De Geer, 1778) is noted.

Hepialids are represented in the Nearctic Region by four genera: *Gazoryctra* Hübner [1820]; *Korscheltellus* Börner, 1925; *Sthenopsis* Packard [1865]; and a fourth undescribed genus which includes members of the *californicus* species group (Wagner, 1985). The first two genera are circumpolar, although no species common to both North America and Eurasia has been recognized. *Gazoryctra* contains ten nearctic species and three palearctic species (Viette, 1949, 1953; Wagner and Tindale, in press). *Korscheltellus* contains a single North American species and several Eurasian species (Viette, 1949, 1958). The four *Sthenopsis* species are confined to montane areas and the higher latitudes of North America (Forbes, 1923; Wagner and Nielsen, in prep.); the palearctic hepialids formerly placed in *Sthenopsis* represent a related, undescribed genus which is currently being revised by Nielsen and Wagner (in prep.). The three species of the *californicus* group are restricted to western North America and appear to form the sister group of the palearctic *Phymatopus hecta* (Linnaeus, 1758) (Wagner, 1985).

Adults of *Korscheltellus* are dark or gray-scaled moths with mottled forewings; forewing lengths range from 12–20 mm. Characters which serve to distinguish *Korscheltellus* from other Hepialidae include the reduced, two-segmented labial palpus; a protibial epiphysis; a weakly developed vein Sc1; the absence of a metatibial androconial hairpencil; and in the male genitalia, the anteromedially inflected tegumen and the elongate and simple valva (without a basal lobe or strongly melanized spines).

The four named North American *Korscheltellus* were originally described in the genus *Hepialus* Fabricius, 1775: *gracilis* Grote [1865]; *labradoriensis* Packard [1865]; *mustelinus* Packard [1865]; and *furcatus* Grote, 1883. All are treated here as conspecific. The first three species were described in the same number of volume three (1864) of the Proceedings of the Entomological Society of Philadelphia, which appeared in March of 1865 (Brown, 1964). Although *mustelinus* has page precedence, *gracilis* is the more widely used name and its type is still extant, and therefore, it is held to be the valid name.

Korscheltellus gracilis recently has been implicated as a forest pest in New England and is targeted for intensive study by the United States Forest Service. This paper is meant to review the taxonomy of the group and summarize existing distributional

and biological data. *Korscheltellus gracilis* is redescribed below. Characters known to vary within the genus and in related palearctic taxa are emphasized. Genital nomenclature follows Birket-Smith (1974), Ueda (1978), and Nielsen and Robinson (1983); veins are named as in Nielsen and Robinson (1983); scale ultrastructural terminology follows Downey and Allyn (1975) and Kristensen (1978).

Korscheltellus gracilis Grote, **New Combination**

Hepialus gracilis Grote [1865]:522. Type Locality: Canada, Quebec. Type: female in ANSP.

Hepialus mustelinus Packard [1865]:393. Type Locality: USA, Maine, Brunswick. Type: female, lost? New Synonymy.

Hepialus labradoriensis Packard [1865]:394. Type Locality: Canada, Labrador, Salmon Bay, Caribou Island. Type: male in MCZ. New Synonymy.

Hepialus furcatus Grote, 1883:30. Type Locality: USA, New York, Adirondacks. Cotypes: three males and one female, lost? New Synonymy.

Redescription. Male (Figs. 1, 2): forewing length: 13–15 mm. Antenna with 23–28 segments. Labial palpus short, 0.15–0.18 mm, two-segmented, the distal segment reduced, sensory pit apical; apex of mentum with short membranous extension (Fig. 3). Maxilla well developed, more than 0.10 mm. Head and thorax with long tan to black trichoid scales, both light- and dark-tipped; dark scales on palpi, under eyes, and thoracic venter. Epiphysis one third length of protibia, nearly twice as long as broad, apex acute (Fig. 4). Forewing mottled with tan, fuscous, and black scales, with indistinct basal band of paler scales running from wing base to inner margin before tornus, and with oblique band from postmedian area of inner margin to apex. Venation (Fig. 5): Sc1 vestigial, R2+3 long-stalked, separating between 0.62–0.72 length of R3. Forewing scales at least twice as long as broad, with deeply toothed apices (Fig. 8). Secondary ridges usually distinct; fluting conspicuous; windows separated by one or two arcing transverse flutes, small, round to irregular, bordered by either ring of unmodified cuticle (Fig. 9) or raised quadrangular area (Figs. 12, 13); window membrane often present. Hindwing fuscous, patterned at apex. Fringe checkered, darker scales adjacent to veins. Abdomen tan to dark brown, anal tuft often obscure.

Male genitalia. (Fig. 6). Genital capsule approximately circular in caudal view. Anterodorsal margin of tegumen with inflection along midline; valvellar processes long, projecting caudad, strongly melanized apically, apex and ventral margin microserrulate. Mesosome tongue-like, distal half bent ventrad at ca. 45 degrees. Lateral margin of juxta constricted before caudal margin. Valva elongate, narrowed below costa, with lightly pigmented costal tooth; setose over distal half. Vinculum broadly U-shaped; saccus differentiated as a shallow ventral lobe; acrosternite triangular or rounded.

Female. (Fig. 2). Forewing length 14–19 mm. Antenna with 25–28 segments. Wings often lightly scaled; ground color pale brown, maculations diffuse, few black or white scales, oblique and basal bands often broad, confluent along inner margin.

Female genitalia. (Fig. 7). Corpus bursae ovate, extending to caudal margin of A6, nearly as long as ductus bursae. Papillae anales narrow, setose over distal half, modestly differentiated from T8 dorsad, with deep medial notch or free over midline, anterolateral portion constricted and then flared at base. Subanal plate elongate,



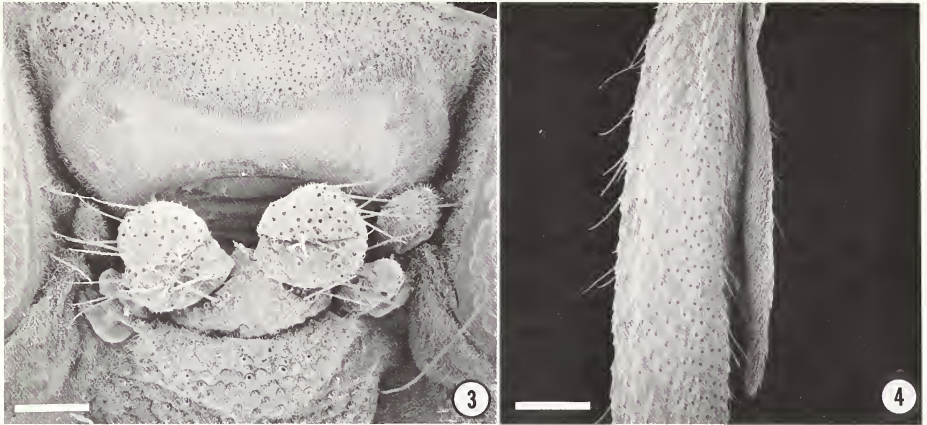
Figs. 1, 2. *Korscheltellus gracilis* adults: 1. Male; 2. Individual variation, males on left and females on right.

obliquely quadrangular. Medial lobe 1.2–2.0 \times as broad as long, setose. Lateral plate weakly differentiated, setose, circa 3 \times as broad as long.

Diagnosis. Generic features will separate *K. gracilis* from all other nearctic swift moths: adults small, darkly mottled; epiphysis about one third length of protibia; tibial spurs absent; in males, metatibial androconial brush organs absent. The male genitalia are diagnostic: mesosome tongue-like; acrosternite prominent; valvellar processes long, horn-like, and strongly melanized.

Korscheltellus gracilis closely resembles the palearctic species *K. fusconebulosus* (De Geer, 1778). *K. fusconebulosus* tends to be larger and more strongly marked. The forewing of male *gracilis* rarely has pronounced spots of white scaling, whereas that of *fusconebulosus* often has a white spot at the base of M1 and/or a second spot over the confluence of M2 and M3 in the cell. The male of *fusconebulosus* frequently has a series of submarginal spots that are absent in *gracilis*. The valvellar processes in *gracilis* are short, curve outward apically and project venterocaudad; those of *fusconebulosus* are longer, run nearly parallel, and project downward.

Variation. Like many other hepialids, differences in color and pattern are considerable. Adults from Camels Hump, Chittenden Co., Vermont, range from light brown to nearly black. Northern specimens (e.g., Newfoundland) tend to be dark brown with obscure maculation. Males from the Great Smokies also tend to be dark. Females and older individuals are often sparsely scaled. Variation occurs in several genital structures. The costal tooth on the valva is small and rounded in some specimens, prominent and acute in most. The acrosternite can be acute or rounded. The dorsal margin of the vinculum is entire or bears a small condyle at its basal articulation with the valva. In some populations the shape of the 8th sternite is variable, ranging



Figs. 3, 4. Scanning electron micrographs of *Korscheltellus gracilis*: 3. Head, frontal view, scale = 200 μm ; 4. Epiphysis, scale = 60 μm .

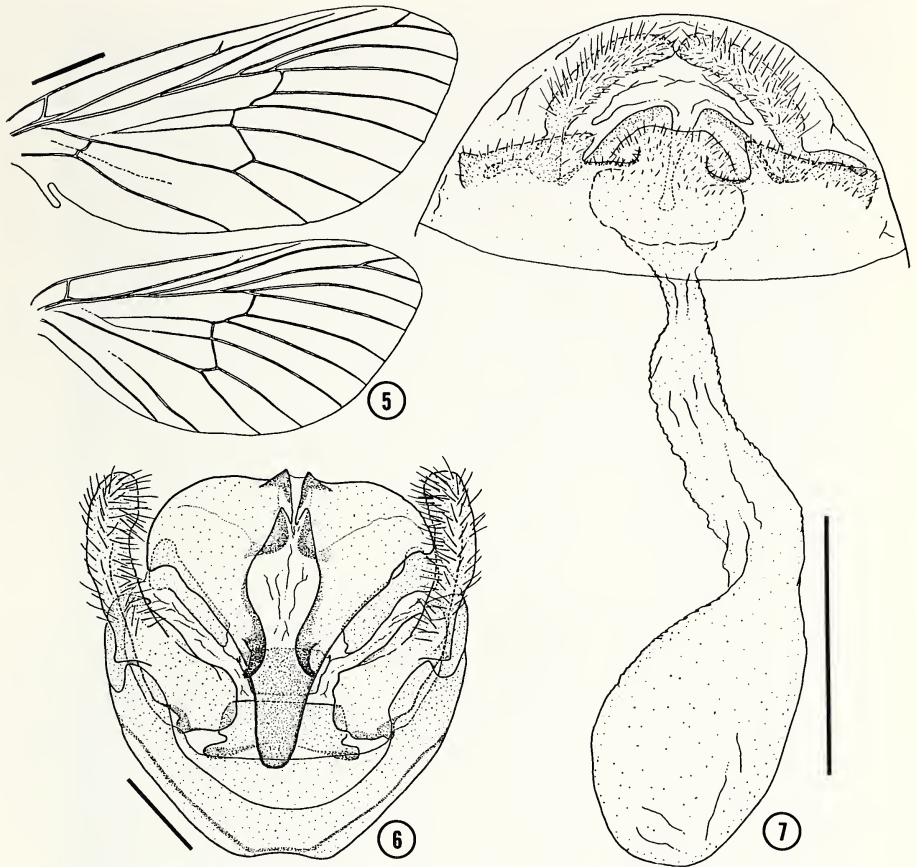
from twice as broad as long to nearly quadrangular; its posterolateral margin is entire or emarginate.

Material examined. 441 males, 83 females, and 15 unsexed specimens from eastern North America. Label data are available upon request. The primary types of *labradoriensis* (DLW Slide 86-82) and *gracilis* (DLW Slide 87-05) were examined. The female type of *mustelinus* was not with *labradoriensis* in the Packard Collection in the MCZ and is presumed lost. The types of Grote's *furcatus* were not in the ANSP with the type of *gracilis*, nor were examples found in the Buffalo, British, or American Museums of Natural History, known depositories of Grote's material (Horn and Kahle, 1935).

Distribution (Fig. 14). Labrador (to 53.5°N lat.) west to Hudson Bay, Ontario, and Edson, Alberta, south to Wisconsin and Michigan, and in the Appalachians to North Carolina. Across eastern North America, the range of *gracilis* corresponds to that of the boreal life zone.

Specimens labeled "Manchester [brown ink], Massachusetts [black ink]" from the Henry Edwards collection (in USNM, BMNH, and ANSP) appear to represent mislabeled *K. fusconebulosus*. All are larger and have more antennal segments than typical *K. gracilis*; the male genitalia agree with those of *fusconebulosus*. Perhaps these moths were collected in Manchester, England, and then inadvertently mislabeled. A specimen in the LACM labeled "Westfield, Union Co., N.J." would seem to be mislabeled. Forbes' (1923) reference to *gracilis* from Colorado is almost certainly in error, and probably refers to *Hepialus hectoides* Boisduval, 1868.

Remarks. Neither Packard nor Grote examined venation or prepared dissections. The original descriptions of *furcatus*, *gracilis*, *labradoriensis*, and *mustelinus* addressed only superficial differences in wing pattern (such characters are highly variable in the Hepialidae as in many other nocturnal Lepidoptera). Phenotypic variation in large series exceeds that presented in the four descriptions by Packard and Grote. A specimen of *Korscheltellus gracilis* from Hudson Bay, Canada, in the BMNH, is labeled with a manuscript name, *Hepialus griseus*.



Figs. 5-7. *Korscheltellus gracilis*: 5. Wings, scale bar = 2.0 mm; 6. Male genitalia, caudal view, scale bar = 0.25 mm; 7. Female genitalia, ventral view, scale bar = 1.0 mm.

BIOLOGY

The small, shiny black, ovoid eggs are smooth with indistinct micropyles. One female can lay a few hundred eggs which hatch after one or two weeks (Packard, 1895).

The larva is a subterranean polyphage feeding on roots externally or boring into below-ground tissues. Felt (1906) recorded larvae of *Korscheltellus gracilis* in association with the roots of spruce (*Picea* Dietr.). Packard (1895) found moths common in stands of red spruce (*Picea rubens* Sarg.) in Brunswick, Maine, and assumed this to be the larval foodplant. In Canada the larvae have been associated with the roots of white spruce (*Picea glauca* Voss), balsam fir (*Abies balsamea* Mill.), and yellow birch (*Betula lutea* Michx.) (Prentice, 1965). D. Tobi (pers. comm.) found larvae in association with below-ground portions of red spruce, balsam fir, paper birch (*Betula papyrifera* var. *cordifolia* Fern.), and the fern, *Dryopteris campyloptera* Clarkson.

Korscheltellus gracilis has a two-year life cycle over much of its range. Although adults fly every year at a given locality, years of abundance alternate with poor ones. Large series of adults have been collected at four localities over a span of three or more years: at Lake Katherine, Oneida Co., Wisconsin, from 1945–1963 by H. M. Bower; at [St.-Theodore-de-] Chertsey, Quebec, from 1966–1969 by L. Le Sage; in southern Nova Scotia, from 1957–1979 by D. C. Ferguson and B. Wright; and on Camels Hump, near Huntingdon, Chittenden Co., Vermont, from 1984–1986 by D. Tobi. At Lake Katherine and in Nova Scotia most adults have been captured in odd-numbered years, with only occasional records for even-numbered years. At Camels Hump and Chertsey, most captures have been made in even-numbered years.

The adults fly at dusk from the end of June until the middle of August with the majority of records falling between mid-July and early August. The males are strong, erratic fliers, careering among trees and underbrush in search of females (Engelhardt, 1920). Adults are attracted to light.

Korscheltellus gracilis is principally an inhabitant of coniferous forests. It is especially common in stands where red spruce and balsam fir are dominants (D. Tobi, pers. comm.). In the southern Appalachians *gracilis* is a high elevation species, but in Maine, Nova Scotia, and northward, colonies may occur at sea level.

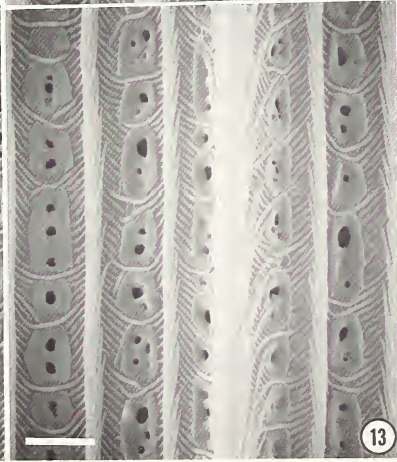
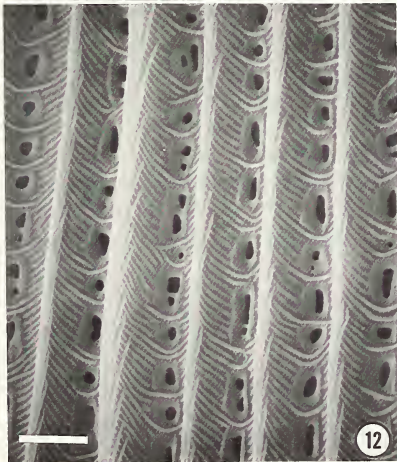
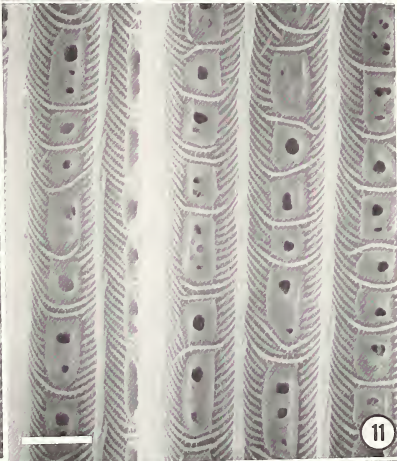
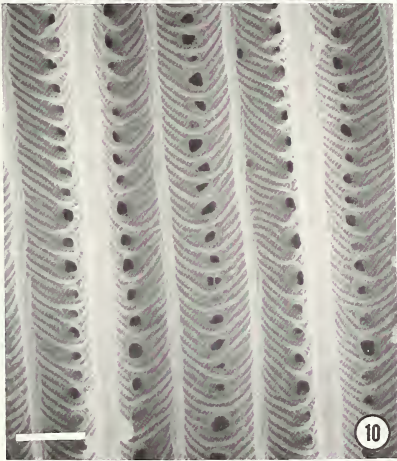
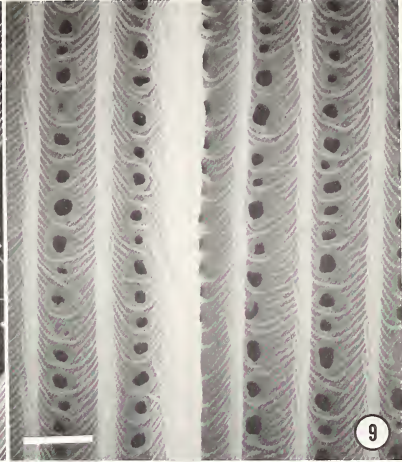
DISCUSSION

Fabricius created the genus *Hepialus* for *Phalaena (Noctua) humuli* L. in 1775. Since that time the genus *Hepialus* has been used by lepidopterists worldwide for small, nondescript Hepialidae, whereas large colorful or otherwise distinctive species have been placed in other genera. However, several characters indicate that *Hepialus humuli* and the members of the holarctic genus *Sthenopsis* (with *Zenophassus* Tindale, 1941, *Aenetus* Walker, 1856, and perhaps others), share a common ancestor not shared by many “*Hepialus*” species. Synapomorphies for the two taxa include (1) metatibial hairpencils in males, (2) swollen metatibiae in males,¹ (3) triangular forewings with falcate apices, (4) forewing scales with rounded apices, and (5) the absence of an epiphysis in all but *Aenetus*. Hence if *Sthenopsis* is to be retained as a distinct genus, as has been done by all lepidopterists since the genus was first described by Packard in 1865, then more distantly related “*Hepialus*” species are properly classified in other genera.

The generic placement of *gracilis* is problematical. The Eurasian *fuscinebulosus* appears to be the most closely related hepialid to *gracilis*. Some individuals of the two moths, especially females, are nearly indistinguishable. Taken together, they

Figs. 8–13. Scanning electron micrographs of forewing scales from the median area: 8. *Korscheltellus gracilis* forewing scale; 9. Ultrastructural of same, typical micromorphology; 10. *Pharmacis carna*; 11. *Korscheltellus lupulinus*; 12 and 13. *Korscheltellus gracilis* from Wisconsin and Ontario, respectively. Scale bar = 50 μm for Figure 8 and 3.0 μm for Figures 9–13.

¹ Some *Aenetus* species and members of the “*Sthenopsis*” *regius* group have secondarily lost the swollen tibiae and hairpencils.



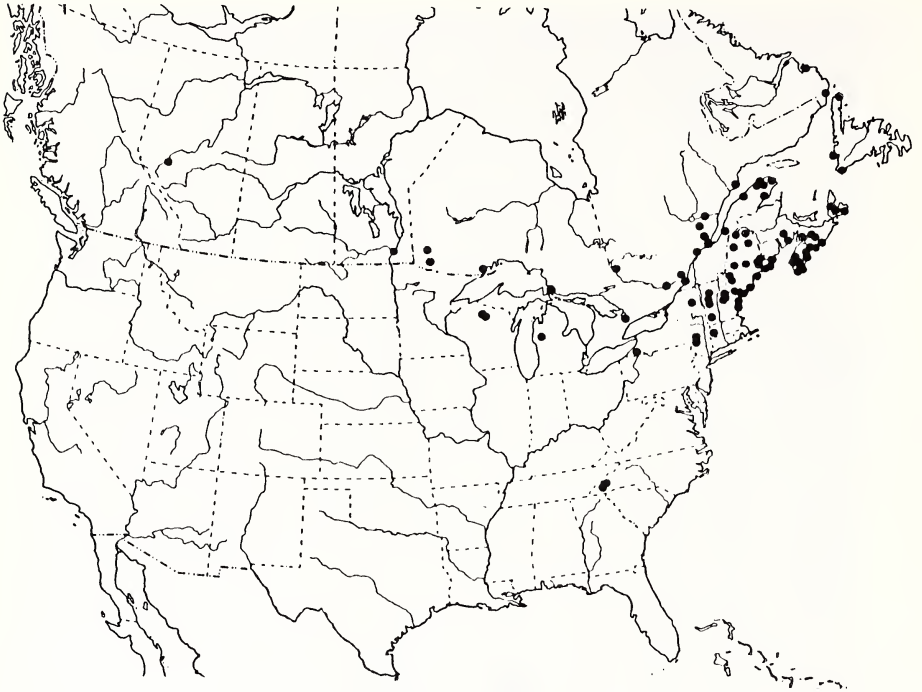


Fig. 14. Distribution of *Korscheltellus gracilis*.

show affinities to two palearctic genera: *Korscheltellus* (type species: *lupulinus* L., 1758) and *Pharmacis* Hübner [1820] (type species: *carnea* Denis and Schiffermüller, 1775). *Korscheltellus* can be characterized by male genital and wing scale ultrastructural characters; synapomorphies for *Pharmacis* have not been identified.

Viette (1948, 1949, 1958) placed *fusconebulosus* in *Korscheltellus* because of similarities in the male genitalia, but he did not describe specific structures. An examination of the male genitalia of *lupulinus* and *fusconebulosus* (along with *gracilis*) supports his view: all share simple, elongate valvae; horn-like valvellar processes; free processus momenti that lie in the same plane as, and below, the tegumen; a hat-shaped juxta, constricted before the vincular margin; a tongue-like mesosome; and a triangular or rounded, dorsally projecting acrosternite.

The forewing scale ultrastructure of *gracilis* suggests an affinity to *Pharmacis*. The scales of *Pharmacis carnea* bear small circular to irregular windows surrounded by a ring of smooth cuticle; adjacent windows are separated by one or two (occasionally more) arcing transverse flutes (Fig. 10). The typical ultrastructure of *gracilis* is similar (Fig. 9). The wing scale ultrastructure of *Korscheltellus lupulinus* differs markedly from the above. The window membrane is often present, and groups of windows are surrounded by quadrangular areas of raised cuticle (Fig. 11). However, the occasional specimen of *gracilis* is intermediate, seemingly bridging these two scale types (Figs. 12, 13).

The forewing color and pattern of *Korscheltellus*, *Pharmacis*, and *gracilis* are gen-

erally similar. Males tend to be mottled with various brown, tan or gray scales; the markings are especially close in females. All are moderately small hepialids with forewing lengths rarely exceeding 19 mm.

As evident from the above, it is not possible to definitively assign *gracilis* to either *Korscheltellus* or *Pharmacis*. It is quite possible that *Korscheltellus* will prove to be a subordinate taxon within *Pharmacis*. For now, I follow Viette (1948, 1949, 1958), Popescu-Gorj (1979), and Inoue (1982), in placing *gracilis* with *fusconebulosus* in the genus *Korscheltellus*.

In July of 1985, a male of *Korscheltellus fusconebulosus* was intercepted in Florida by the United States Department of Agriculture. The individual was collected from an air cargo shipment that originated in Denmark.

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